EXPERIMENTATION OF COMPLEX ADAPTIVE AEROSPACE MISSION CAPABILITIES

by

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Research Plan

for a

Doctorate of Philosophy

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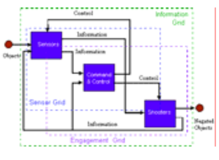

STUDENT'S DECLARATION

I declare that this Research Plan does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any university. To the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text.

Please note that this plan is drawn from unclassified, open sources and are those of the author. To the best of the authors knowledge this proposal does not contain any commercial-in-confidence or classified material. The views expressed do not necessarily represent the extant official views of the Royal Australian Air Force, the Department of Defence, the Australian Government or Tenix Defence Aerospace.

This research plan is seeking to promote awareness and discussion on where experimentation can be used to improve the operational use and understanding of network centric operations and interoperability with Australia's joint forces, major allies and coalition partners as we undertake the transformation to a network enabled, effects-based capable air force.

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What is a system? As any poet knows, a system is a way of looking at the world.

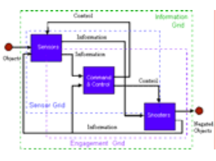
Gerald M Weinburg

There is nothing more necessary to the man of science than its history, and the logic of discovery.
The way error is detected, the use of hypothesis, of imagination, the mode of testing.

Lord Acton

Test everything. Keep that which is good.

1 Thessalonians 5:21



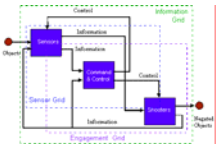
EXECUTIVE SUMMARY

In August 2007, a research proposal was submitted to investigate the experimentation of complex adaptive networks for future aerospace mission systems in Australia. The research was occasioned by the candidate while he was the Chief Engineer for Tenix Defence Aerospace as one measure to better position the company for undertaking inter alia the AP-3C Orion Upgrade. Approval by the University of South Australia's Ethics Committee was received in April 2008, with no changes or issues identified.

However, in the changing world of defence research and organisational turbulence today, the playing field has already changed with one of the major research areas Defence Force Capability Technology Centres being proposed that would be focusing on the broad issues involved with the research area, the creation of the ADF Test and Evaluation Organisation (ADTEO) in Capability Development Group and the acquisition of Tenix Defence Pty Ltd by BAESYSTEMS. The candidate also restarted in the ADFs Reserve Staff Group as an Analyst for the Defence Intelligence Organisation and was also one of a dozen retired officers approached to rejoin the Royal Australian Air Force (RAAF) in October 2007. He did so in late January 2008 as the Director of Trials and Range Management in Air Force Headquarters (AFHQ). AFHQ has enthusiastically agreed to support the proposed PhD program. The candidate along with his supervisor and new co-supervisor reviewed the proposal and agreed that this Research Plan should be initiated.

In the broadest terms the candidate plans to review the current methods used for capability development and management practices and to recommend a code of best practice for the experimentation and testing of complex adaptive aerospace mission systems and air armament.

The candidate proposes to improve the quantity and quality of research responses via his recently becoming an invited membership of the North Atlantic Treat Organisations (NATO) Research & Technology Organisations (RTO) Flight Test Technical Team (FT3). Since the time of the research proposal the candidate has already had initiated a project with the NATO RTO FT3 to address the proposed research. The candidate also proposes to use the National Test Pilot School to ensure that the methods are appropriate to flight test. Heuer (2003) also proposes the radical strategy of applying the scientific method to intelligence analysis activities. Such an approach could provide a breakthrough in the application of experimentation to the capability development and management processes at the joint mission level.



BACKGROUND

At that time [in 1909] the chief engineer was almost always the chief test pilot as well.
That had the fortunate result of eliminating poor engineering early in aviation. *Igor Sikorsky*

The contemporary conventional wisdom is that on the battlefields and battlespaces of the near future our soldiers, sailors and airmen will be presented with ever increasing voluminous and often conflicting data from multiple sources and will face ‘cognition overload’. The very nature of future asymmetric warfare[1] requires that such data and information must be rapidly processed, coordinated and systematic responses to these threats coming from all dimensions be exploited effectively with synchronised, appropriate and balanced responses, Corbin et al, (2007). In the Australian context, the Defence Capability Manual at Commonwealth of Australia (2006) outlines how such capabilities are to be developed and managed using the Future Joint Operating Concept at Commonwealth of Australia (2007) so that our ‘balanced, networked and deployable’ joint forces can ‘reach, know and exploit the future operating environment’. Lough (2007) reinforced the importance of this approach in a brief on Australia priorities for the Defence Science & Technology Organisation (DSTO) to attendees at the National Defence & Industry Association (NDIA) sponsored conference. Bentley (2006) provides the best overview to date as to what this may mean to the ADF Air Delivered Weapons Roadmap yet available to understand the expected future air armament needs of the ADF. Whether this is enough to counter the future threats of higher performance combat aircraft with equivalent (if not the same) equipment entering the region or may be considering operations counter to Australia’s national interests such as the hypothesis being put forward by Kopp (2006) and other pundits remain to be seen. There is also continued controversy as to the approach and the success of the Kinnaird Review (2003) for capability management and it’s implementation for major systems by the Capability Development Group (CDG) and the Defence Materiel Organisation (DMO) in delivering promised capabilities to the Service Users. Whether such controversy and noise is warranted or just par for the course deserves better scientific insights to determine what may improve the signal to noise ratio.

The implications of this paradigm for the network enabling of Australian air power was the subject of research at Tutty (2005). The subsequent Research Proposal of 30 August 2007 and hence this plan was one of the principle conclusions for further research resulting from that work. The current research is not intended to replicate such work but to seek innovative and novel ideas for the experimentation of Australia’s future Aerospace Mission Systems[2] to continue the transformation of current research and best practices for Australian and Coalition doctrine, tactics and training for Australias future air power.

The candidate is also keen to explore whether the extant systems engineering paradigm is well suited to the research and creativity needed for future capability management. In fact Rutan (2007) – a world reknowned novel aircraft designer, aviator and also a flight test engineer – provided the following similar views at the same conference as Lough (2007):

1 A military term originally referring to war between two or more actors, or groups of actors, whose relative power differed by a significant amount. Contemporary military thinkers tend to broaden this original meaning to include asymmetry of strategy or tactics; today "asymmetric warfare" can describe a military situation in which two belligerents of unequal power interact and attempt to take advantage of their opponents' weaknesses. Wiki (2007)

2 For the purposes of this research an Aerospace Mission System includes: the Air or space vehicles’ Data Management System, Navigation, Communication, data links, ground control station, electronic surveillance and warfare systems such as RADAR, Electro-Optic / Infra-red, Acoustics, EWSP, etc **and** the Armament/Ordnance Stores Management / Fire Control Systems.

"F-22 Raptor and F-35 Lightning II - Another 40 years with 1960's performance?
Requirements based on perceived need, not a desire to find performance breakthroughs.
–Air superiority in < 2 days, last two decades.•
Requirements direct Development Programs, not Research.
–Industry employs a new generation of aerospace engineers who think development **is**research.
–Risk averse requirements breeds risk averse technical progress." [Slide 31]

"**The education statistics are bleak**
- **Science vs. lawyers / media / politicians / actors*** * And other criminals•
- **The real reason** –we are boring our youth – Development vs. research•
- **The solution** – take real risks–Exploration – Adventure–Breakthroughs•
- **Strive to be great, not to be 'equal'"** [Slide 52]

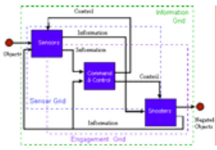
SIGNIFICANCE OF THE PROBLEM

All aeroplanes share problems in common. When the airspeed is too slow they lose lift, reach a minimum level flying speed, or they stall, sometimes quite violently.
An aircraft designer, like a test pilot, must be streetwise in all matters which affect conduct of an effective flight with the highest level of safety for it's intended purpose. He or she must be practical above all.
The test pilot and the designer must know their history – of what has been attempted before, and what has failed and why? Nature has its own laws and never breaks them. *Stanton (2001), pg xix.*

Enterprise Context

The Australian Defence Force (ADF) is currently experiencing a level and scope of regional and international military combat and support operations unprecedented since the Vietnam War in the 1960 and 1970s, Commonwealth of Australia (2007). In fact ten major operations are currently underway with over 12% of the ADFs uniformed personnel deployed overseas in direct support. This is expected by some respected defence analysts to continue and may well be a generational issue for the Coalition partners, Winters (2007). According to the ADFs Defence Capability Plan at Commonwealth of Australia (2006a), the DMO will also be seeking to acquire over the next decade advanced avionic systems for numerous updated and new capabilities including the venerable AP-3C Orion aircraft and weapon system. This will be accomplished under an incredible number of Major and Minor acquisition programs worth billions of dollars per year to bring into service, maintain and further enhance the ADFs aerospace capabilities and in the longer term to achieve tailored effects during network enable, effects based operations (NEO / EBO). The AP-3C Block Upgrade Program intends for the AP-3C weapon system, including the aircraft, it's associated simulators and support systems to be interoperable with not only other key ADF aircraft but must be compatible with key allies and coalition partners. This will transpire principally via agreements and standards established by the North Atlantic Treaty Organisation and the Air & Space Interoperability Council (ASIC – until recently the Air Standardization Coordinating Committee).

Research into the application of systems engineering, to address network enabled operations for future ADF capabilities, being acquired by the DMO, is timely due to the extent of the Block Upgrade programs, there considerable cost, and the considerable difficulties being experienced with several other aircraft integration programs. The DMO does not currently have a consistent experimentation, systems engineering or test and evaluations framework to apply to the various Block Upgrade Projects to specify, integrate and certify the changes to key mission systems let alone achieve the FJOC levels expected at Commonwealth of Australia (2007). Poor tailoring and application of the Australian Defence Contracting (ASDEFCON) suite of contracting requirements of Commonwealth of Australia (2005) for Major Systems to the typical DMO project and engineering activities urgently needs addressing.



Aerospace Mission Systems Context

Aerospace Mission Systems such as the AP-3C Orion aircraft that was the original trigger for the proposed research are critical to Australia's national and international combat capabilities and in the case of the AP-3C to Australia's maritime patrol reconnaissance and strike capability and play a significant role in Australian border protection, including operations in the Middle East and other parts of the world. Under the DMOs incentive to Australian local industry, Australian Aerospace and Tenix Defence were selected to work with the Commonwealth Australia to develop an innovative and co-operative through life support solution for the AP-3C aircraft and weapon system up to at least 2018. This contract establishes management arrangements under the AP-3C Accord Master Agreement to integrate and coordinate AP-3C upgrades and maintenance worth over $1 Billion AUD, Nelson (2006). The rationale and status of the P-3 Accord are explored in considerable detail by Hensley (2007).

In support of the proposed capabilities enhancements to the AP-3C aircraft, integration of new weapons, fixing defects to software, other modifications and enhancements to the AP-3C Aircraft Software Intensive Software System are required. The AP-3C Aircraft Software Intensive System consists of the following major mission systems: RADAR, Navigation, Communication, Acoustics, Armament/Ordnance Stores Management and Data Management System. These systems were originally developed by different vendors for the DMO, hence the product architecture, specifications, developmental tools and processes varies significantly from system to system. Managing changes to these software systems is not a trivial exercise. Standard process models aimed for software developmental environments are not proving fruitful for the proposed upgrade, Parikh (2006). The software support agency needs a comprehensive process model for software maintenance that balance initial costs, long term operations, life of type maintenance costs, and the potential costs of catastrophic failures.

Operational Capabilities Context

In amongst all these proposed systems upgrades, DMO must not forget that these systems need to be operated in training and combat operations by personnel that will not be super-humans capable of feats of understanding and dexterity unheard of before. Lidwell et al (2005) provides some useful principles of design that go a lot further than blindly implementing human factors standards such as MIL-STD-1472 (1999) established before the Internet and the Gameboy® were even thought of! The candidate has recently developed a P-3 Engineering Management System (EMS) and P-3 Systems Engineering and Certification Guidelines at Tenix FX-0119A001 (2007) and Tenix FX-0119A001-22 (2007) as the primary approach for all Tenix design, V&V and in-service support under the P-3 Accord Master Agreement. The P-3 EMS is vital to Tenix activities as a DGTA approved Authorised Engineering Organisation (AEO). Note that the latter document also identifies the need for the introduction of a "Fly-Fix-Fly" approach to be included as a suitable alternative for future P-3 software development and V&V (currently all functions are tested and "sold off" solely based on Acceptance Tests done in the P-3 Systems Engineering Laboratory!) that will hopefully address 92 Wing[3] and operational crews concerns with the current "big bang" contracting approach of the DMO wherein all functions and capability are introduced at once – with

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3 92 Wing – Located at RAAF Base Edinburgh, SA, 92 Wing is responsible to the Commander Surveillance and Response Group of the RAAF for all maritime patrol capabilities which are currently undertaken by the using the AP-3C weapon system.

minimal crew engagement in the specification and system testing! Smith (2007) seeks to further the DGTA engagement with such an approach. In fact, one of the primary reasons for the publication of Tenix FX-0119A001-22 (2007) was to establish a basic systems engineering and certification framework using the philosophy at Tutty (2005) as appropriate to the AP-3C aircraft that will be a useful benchmark for this research program – as DMO and Tenix Defence did not have one at all until then! This approach will be explored further during the proposed research.

International Perspective

Given the US investment in S&T is $USD 1.655 Billion as presented by Bowlds (2007) and that a significant portion of the DARPA budget is also being spent on technology insertion according to Stotts (2007) what will be necessarily unique about this proposed research? Hopefully this research will be able to prove or disprove that standards compliance and technology insertion are only part of the equation and that such technology development needs to be guided by humans and that aerospace operations can be more logically prepared for by those humans undertaking tailored, relevant experimentation or mission rehearsals. If so, how should they do this for the Australian profession of arms, with an Australian ethos and for an Australian scale of military operations in a Coalition and joint mission context is a most interesting question.

LITERATURE REVIEW

The tenets of network centric operations are:

1. A **robustly networked force improves information sharing**.
2. **Information sharing and collaboration** enhance the quality of information and **shared situational awareness**.
3. **Shared situational awareness** enables **self-synchronization**.
4. These, in turn, dramatically **increase mission effectiveness**.

Alberts & Hayes (2007)

Tutty (2005) is essential prior reading for this research, as it covers the broader aircraft stores capability issues and the candidate does not plan to needlessly go over the same ground again except to note fundamental changes requiring further investigation: as there are simply so many exciting things happening in the research area proposed, that such a strategy is unwarranted. The Executive Summary for that research is, however, worthy of inclusion (with emphasis added as it specifically pertains to this research) to set the context and starting point of this work:

> *"In recent years there has been a revolutionary shift in the focus of the profession of arms. The shift has occurred away from the platform-centric view popularised by the politicians and media as to how many tanks, planes and boats are needed for the defence force, to that of a capability management construct that is to be network-centric, interoperable and effects based. This is achieved by treating the military capabilities to achieve those end-effects as families of systems that need to be managed across the whole life cycle. The ability to undertake predictive modelling and simulation of the capabilities options available to a joint force commander to achieve the desired end-effects in the time available means that network-centricity is vital to capability development, as it is to those undertaking the combat operations.*
>
> *The level of interoperability of aircraft and stores is vital to Australia being able to fly and fight with our allies. Interoperability is, without exception, given a very high priority early in aerospace weapons programs in setting the standards required, but then seems to be left behind when fiscal realities start hitting home to save costs to that specific program.*
>
> *The level of interoperability for network enabled aircraft stores capabilities that are based on aircraft stores configurations certified by nationally recognised airworthiness bodies needs to, however, mature beyond such a technical emphasis to one of a people emphasis by addressing the command and control, and organisational elements to achieve certification of interchangeable aircraft stores capabilities at acceptable levels of risk during concept*

development, capability definition, acquisition and in-service phases. The current initiatives of the Air Standardization Coordinating Committee member nations, namely Australia, Canada, New Zealand, UK and the US, and several key commercial standardisation organisations that will affect how future aerospace weapon systems will be integrated, to achieve interoperability between joint, allied, and coalition forces will be critically reviewed and options discussed to increase awareness of the challenges facing us.

This thesis, therefore, has as its central premise the vision that Australia's future joint defence force, will inevitably, have key operational and support systems network enabled with sensor and engagement platforms connected to it. The main questions resulting from this central premise are therefore, how soon can we make the most important parts of our joint forces network enabled whilst retaining the level of interoperability between all these families of systems at acceptable levels of risk. ***The prosaic answer is for Australia to focus on providing the secure, tactical level networks at the mission level [see Figure 1 to see how that relates to military operations] for key aircraft stores capabilities, in the short to medium term, cognizant of the reputed transformation in NCW for the strategic and interconnectedness of everything, at all levels, that will occur in the longer term. Australia needs to implement an experimentation program that includes the use of air armament to explore whether such concepts are practicable.*** *With such a bounded problem, systems engineering principles are most useful in helping identify and implement with rationally derived cost, schedule and performance criteria to help better manage the wider community expectations. The antithesis of those expectations is self-evident in the wider understanding of the latest family of systems being planned for use within the next decade to make the network-centric warfare concept operationally effective. As a result of the research undertaken, the author can now navigate his way through the many layers of nuances and acronyms incorporated into the vision for network centric warfare, but does stand in awe as to the sheer magnitude of the [NCW] operational concept envisioned, the systems engineering involved, and the resources that will be used to acquire and validate it in the timeframe being currently espoused publicly and within the defence community.*

Hopefully those having the occasion to read this minor thesis will also ***start to appreciate the magnitude of the network enabled vision being undertaken and the discipline that will be required to achieve it within the fragmented capability management and nascent systems engineering frameworks we have used to date****."*

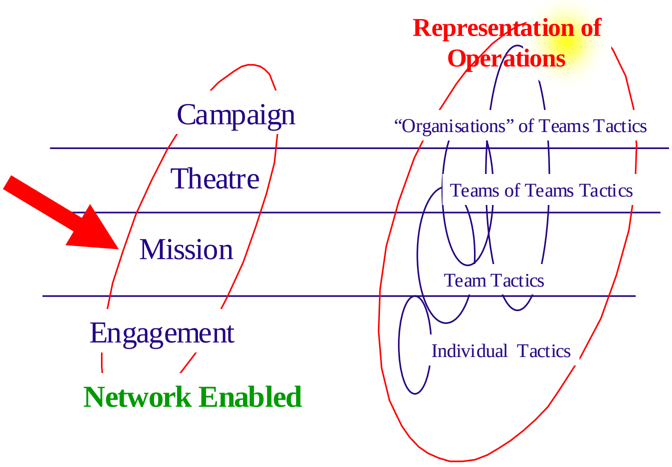

Figure 1. Knowledge Abstraction of Network Enabled and the Military Representation of Operations - Graphic is courtesy Farrier, Appla & Chadwick (2004).

This previous research by the candidate into future Australian and allied air armament and military aircraft electronic (avionic) systems engineering best practices addressed this risk to future ADF operational needs and levels of interoperability to ensure the appropriate and timely allocation of funds for aircraft stores capabilities. Since that research was published, the candidate has taken up a position with industry as the Chief Engineer for P-3 and Force Applications with Tenix Defence Aerospace. It has become apparent that some of the principles ingrained by the conduct of systems engineering and experimentation to determine the extent of aircraft stores compatibility[4] over 25 years may be of extreme benefit to the broader and much more difficult problem of assessing the complete avionic mission system's compatibility and/or interchangeability[5] by using such inductive logic. The author has also been interested for some time in researching the potential for similarly integrating the extensive Modelling and Simulation (M&S) done for aircraft stores compatibility into the ADF's AAP 7001.067 (2004) and MIL-HDBK-1763 (1998) frameworks. MIL-HDBK-1763 (1998), for which the candidate was responsible for Chairing the US Tri-service Committee involved in 1990 and was one of the major contributors for the revision in 1998, identifies for some 40 types of ground and flights tests at the Engagement level the Responsible Test Organisation to be able to meet, minimum criteria for: Purpose, Data Requirements, Test Preparation, Acceptance Criteria, Test Procedure and Test Reporting. Integrating a consistent framework for experimentation and the M&S conducted in support of demonstrating the aircraft avionics ground and flight testing for the capability required may provide a basis for determining the analogous nature of such systems for certification and for effective network enabled operations at higher levels of interoperability without insisting on the use of common systems.

Gartska (2000) and (2005) note that '*A network-centric force has the capability to share and exchange information among the geographically distributed elements of the force: sensors, regardless of platform; shooters, regardless of service; and decision makers and supporting organizations, regardless of location. In short, a* ***network-centric force is an interoperable force, a force that has global access to <u>assured</u> information whenever and wherever needed'***[6]. Portions of Gartska (2000) are worth noting here (as it was worth noting in Tutty (2005)) due to it's applicability to aerospace mission systems and a refocusing since that time is particularly important to the research:

> "Continued exploration of the relationships between information and combat power requires both new analytic tools and new mental models. Ongoing activities to develop metrics for the information domain are hacking through dense conceptual "underbrush" in an attempt to identify a path that can be navigated. A key element of the model is a focus on three domains: the physical domain, the cognitive domain, and the information domain. This conceptual model builds upon a construct proposed initially by Fuller [(1926)], and refined by Cebrowski (1998) [and later in Hayes & Alberts (2002) p 10]:
>
> - **Physical Domain:** The physical domain is the traditional domain of warfare. It is domain where strike, protect and maneuver take place across the environments of ground, sea, air and space. Comparatively, the elements of this domain are the easiest to measure, and consequently, combat power has traditionally been measured primarily in this domain. Two important metrics for measuring combat power in this domain, lethality and survivability, have been and continue to be cornerstones of military operations research.
> - **Information Domain:** The information domain is the domain where information is created, manipulated, and shared. This domain is where the C^2 will occur. The force has the capability to collect, share, access and protect information. The force has the capability to collaborate. This becomes the most sensitive of the domains to protect and defend.

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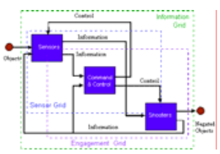
4 Typically this is treated as a "two system compatibility problem" with the "aircraft" and the "stores" it "carries and employs - which uses a consistent aircraft stores compatibility T&E framework via MIL-HDBK-1763 (1998) and the ADF's AAP 7001.067 (2004).

5 Which needs to be treated as an "open ended number of system of systems compatibility problem" and hence is also an interchangeability problem.

6 Garstka (2000) notes that 'a force with these capabilities is not known to currently exist in any of the US Military services or in the armed forces any our Allied or Coalition partners.' Which was true at Tutty (2005) and is still true today.



- **Cognitive Domain:** The cognitive domain is the domain of the mind of the warfighter and the supporting populous. This is the domain where battles and wars are won and lost. This is the domain of intangibles: leadership, morale, unit cohesion, level of training and experience, situational awareness, and public opinion. This is the domain where tactics, techniques and procedures [TTP] reside. Much has been written about this domain, and key attributes of this domain have remained relatively constant since Sun Tzu [(500 BCE)]. The attributes of this domain are extremely difficult to measure, and each sub-domain (each individual mind), is unique. Consequently, explicit treatment of this domain in analytic models of warfare is rare. However, a methodology that begins to address key attributes and relationships of this domain has been proposed by Harmon (1997) in the context of "entropy based warfare.' '…With network-centric operations a fourth input is added, digital information that is exchanged from external sources, such as other fighter aircraft, or airborne surveillance and C^2 aircraft, over a network [see Tutty (2005)] Figures 2-6 and 2-7]."

The issue then really becomes one of data fusion and confidence in the provenance of the data shared and presented to the required User."

As noted in numerous texts and papers since Gartska (2000), such as Signori et al (2001), Alberts & Hayes (2005), Gartska (2005) and Singer (2007) a fourth domain now seems warranted: namely a social-cultural one. Alberts & Hayes (2005) defines this domain as follows:

- "**Social Domain**: The social domain is the domain covering those set of interactions between and among force entities"**.**

This is a welcomed development as the **Cognitive Domain** can now rightly focus on the implementing ability of the persons involved rather than on the C2, management and coordination functions of the **Social Domain**. How this relates to the progression from peace through war and (hopefully) to peace again and these domains of war is key to the national effects-based approach (which not just about weapons effects) of Smith (2003) and has been elegantly summarised by Singer (2007) Slide 4 as shown at Figure 2. This directly impacts on the time that experimentation can be seen to influence. Also of interest here is the distinction being made between the "Art of War" and the "Science of War" during the all too critical "Stability Operations and Transition" Phase to Peace – which the media have highlighted as having not been particularly well done in recent major conflicts – the so-called "winning the peace"!

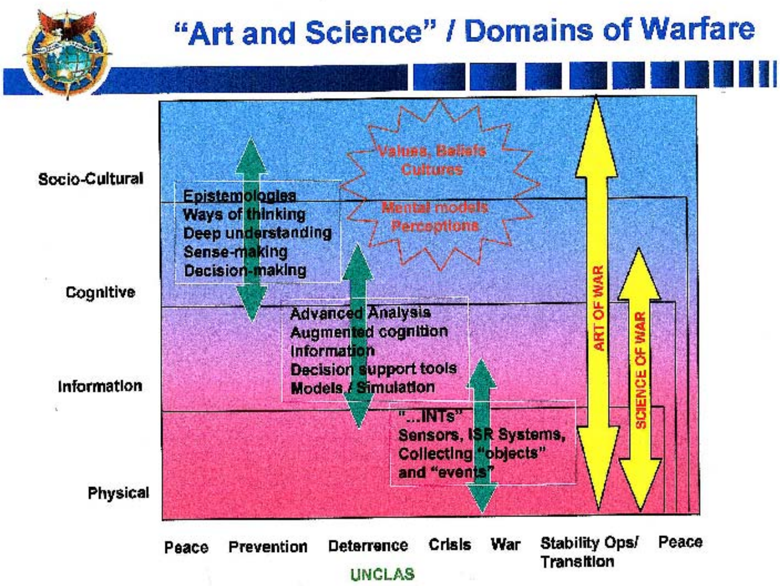


Figure 2. Application of the Art & Science of War and the "Domains of Warfare" – courtesy Singer (2007)

Wars may be fought with weapons, but they are won by men.
It is the spirit of the men who follow and the man who leads that gains the victory.
Col. George S. Patton, Jr, Cavalry Journal, 1933

The proposed research will explore *inter alia* how interoperability initiatives for air armament systems may also be applied to future military avionic mission systems and the systems engineering and experimentation being applied during acquisition of new Australian aircraft capabilities. Network enabling will see the need for the system of systems needing to be certified for use of weapons which will require the rigour of safety-critical, high reliability systems engineering and vastly improved experimentation / modelling & simulation / test and evaluation techniques needing to be applied. The research into whether a code of best practice for an integrated systems engineering and experimentation / test and evaluation framework is achievable for optimising and demonstrating future network enabled capabilities needing aircraft avionic systems in effects based operations will be investigated. Whether contemporary systems engineering and T&E practices are suitable for application with complex adaptive networks will also need to be thoroughly explored. Sadly, this idea was proposed by the candidate prior to the literature review during which an excellent text by Alberts & Hayes (2007) on planning complex C2 endeavours fortunately came to light which proposes that a "cookbook" is needed (the good news) but is "clearly premature at this time" and questions whether can be written and what form it would take (the bad news). As noted earlier, the candidate proposes that the MIL-HDBK-1763 (1998), Hayes and Alberts (2002) and the more recently published TTCP GUIDEx (2006) approaches where a tailorable framework is available as shown at Figure 3 and Table 1 as a starting point and indeed these documents should help provide the compilation of techniques that have been found to be successful by others doing aircraft stores compatibility and experimentation respectively. Such an experimentation "cookbook" will provide a means for planning, comparing the results, assessing technology readiness consistently and thereby enhancing their reliable use in future research/testing that will be of immediate use to practitioners.

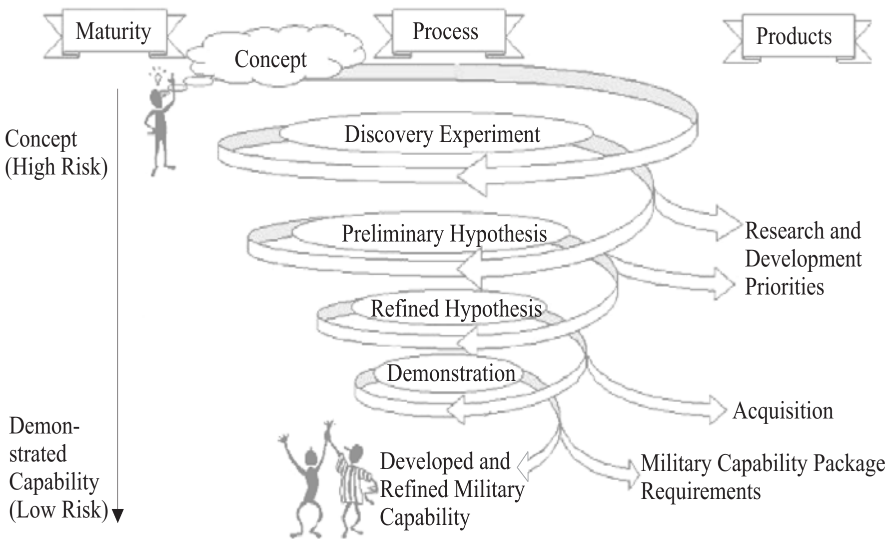


Figure 3. The military experimentation process - adapted from Alberts and Hayes (2002)

Type of Experimentation	***Experimentation Application***	***Aims***
Discovery	Analysis: • Problem Space Examination & Reproduction	To provide some insight into the nature of any new performance variables or relationships that have been demonstrated by the introduction of the concept or capability. To give an idea of future research that may be undertaken in order to further refine the innovation.
Hypothesis Testing	Verification: • Unit Test • Integration Test • Set To Work • DT&E • AT&E	To make comparisons between alternative cases. To show that an effect was created. To show that the cause of that effect is demonstrable. To show how findings can be generalised to some extent to real-world military operations.
Demonstration Experimentation	Validation: • OT&E	To demonstrate a capability or concept that has been proven.To explore the range of conditions over which a capability will exist and to ensure the capability is robust in the military context.

Table 1. Types of Experimentation – courtesy TTCP GUIDEx (2006) and Smith (2007)

Based on the discussion so far in this proposal and some of the feedback provided on Tutty (2005) there could be a (seemingly common) misapprehension amongst scientists and engineers in particular that interoperability, systems engineering and experimentation are all susceptible to resolution by rational logic and scientific reductionism using skills from the "hard sciences". The candidate's professional experience has primarily been seen to be in such arenas as these wherein complicated problems are broken down to be individually solved. However, his experience also supports the view that the "soft sciences" are now playing a larger role in the Information Age transformation when systems are becoming truly networked, Signori et al (2001) and Alberts & Hayes (2005)[7]. This view is also gaining common acceptance in defence and non-defence research – see Moffat (2003), Ball (2004), Surowiecki (2004), Schneier (2004), Ormerod (2005), Clippinger et al (2007) and Crebolder et al (2007). In fact some of the most useful insights found on networks and complex adaptive systems so far in the literature search have come from non-defence applications in the financial and biological fields.

> Leadership is the art of accomplishing more than the science of management says is possible.
> *Former US Secretary of State and Chairman of the JCS Gen Colin Powell*

Finally the candidate believes that a straight forward capability model for network enabled capabilities can be developed that can better explain to end users what confidence there is in the network-enabled mission system working as expected in the scenarios and missions it will be called upon to perform. Today's defence capability models such as that at Commonwealth of Australia (2006) et al seem overly platform centric (still) or are overly complicated in their construction, development, use and to understand, CMMi (2000) and even LAI (2004). They typically approach the problem from a risk reduction rather than a confidence building paradigm. It has been the

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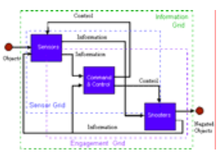
7 Yes, Cebrowski, Alberts, Hayes and Smith of the US Command and Control Research Program (CCRP) are very prolific providers of texts, training and briefings on current and future military C2 challenges and research.



candidate's experience that the majority of operational users and engineers think fundamentally differently and these differences need to address the users needs to better understand their capabilities with a more intuitive set of straight forward tools. Shenhar and Bonen (1997) propose that a two dimensional taxonomy in which systems are classified according to four levels of technological uncertainty and three levels of system scope warrants further investigation using the approach at Tutty (2005). The research proposed by Kew (2006) and (2006a) suggest that the control and optimisation theory along with systems dynamics approaches initiated by Forrester (1969) may provide valuable insights into decision making approaches and may well establish a framework suitable for application with research being pursued here based on the approach of Alberts & Hayes (2007) and the approach of Smith (2003) for effects-based operations. Hari & Cropley (2007) also report on research with agile systems engineering approaches for anti-terrorism applications that indicates that time critical creative solutions and systems engineering need not be mutually exclusive.

During the research planning stage, the candidate has already provided well received, refereed presentations to an International T&E Association (ITEA) Conference in Florida at Tutty (2006) and at the inaugural Asia Pacific Systems Engineering Conference at Tutty (2007). The author has also been able to attend *inter alia* DEFNET 2006 and Information Decision & Control 2007 Conferences to hear several keynote presentations by Welsh (2006) on the ADF NCW Roadmap, Thorenson (2006), Christianson (2007) on "Netready" Key Performance Parameters, Crouch (2007) on T&E / spectrum issues, Stuckey (2007) on US Air Force Systems Engineering developments amongst others and a very impressive ITEA Annual Symposium at Kuaui, HI. Since rejoining the RAAF, AFHQ also supported his attendance at the ITEA C4ISR in a Joint Test and Training Environment and a Society of Flight Test Engineers UAVs on test range Conferences. These presentations and papers were a timely counter point to some very slick theory on the subject espoused by some enthusiastic and Powerpoint savvy acolytes.

RESEARCH TOPIC

A first-rate theory predicts, a second-rate theory forbids and a third-rate theory explains after the event

Alex Kitiagorodski 1975

Previous research by the candidate investigated developments in military aircraft electronic (avionic) systems that are needed for ADF operational requirements for effects based operations to be effective. Recently there has been an ever increasing barrage of articles in the open literature and press highlighting the importance of network-centric warfare (NCW) concepts and network enabled operations (NEO) to future ADF warfighting concepts. The proposed research explores the impact that evolutionary and ever increasingly complex systems, technology readiness and the science of networks have on the rate at which such new capabilities can be created and demonstrated in the Australian context to meet evolving operational concepts and their robustness in use which needs exploration. Many of these systems may well be utilising complex adaptive systems and networks as the underlying technology that will need to be understood for them to be used in military aerospace, safety critical and mission critical applications. If such research can demonstrate that suitable rigour has been applied, it can be expected to significantly influence the approaches the ADF uses to certify that such capabilities are operationally suitable[8][9], effective[10] and prepared[11] for peacetime training, exercises and war.

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8 The degree to which a system can be satisfactorily placed in field use considering: **availability, compatibility, airworhiness, transportability, interoperability, reliability, peacetime training and wartime usage rates,**

Research Problem

The fundamental problem this research will address is:

> ***To what degree can experimentation be used to enhance the confidence in our future network-enabled complex, adaptive, aerospace mission capabilities?***

Sub-problems

The sub-problems used to explore this are:

- **Sub-problem 1 –** What is the utility of the contemporary capability development and management models that are in use?

- **Sub-Problem 2** – What is the suitability of contemporary systems engineering, interoperability and experimentation practices for complex, adaptive military aerospace mission system capabilities intending to be network enabled and used with air armament?

- **Sub-Problem 3 –** Is a code of best practice that incorporates modelling and simulation into experimentation, modelling & simulation and ground and flight T&E frameworks achievable now that can serve to give operational staff more confidence in the operational utility of network enabled aerospace mission systems?

- **Sub-Problem 4 –** Determine insight from case studies of the application of this code of best practice and model to real world avionic mission system upgrades and network enabled operational experimentation.

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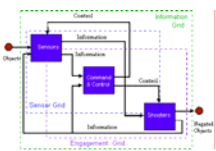
maintainability, safety, human factors, logistics supportability, documentation, and training requirements. AAP 7001.067 (2004)

9 Note that the conventional wisdom is that airworthiness forms one element of operational suitability.

10 The degree of mission accomplishment of a system when used by representative personnel in the environment planned or expected for operational employment of the system, considering **organisation, doctrine, tactics, survivability, vulnerability, and threat, including countermeasures**. AAP 7001.067 (2004)

11 The degree to which **operational readiness** (The ability of a force element or elements (unit / formation, ship, weapon system or equipment), within a specified period of time, to perform the missions, functions or tasks for which it is organised or designed.) and **sustainability criteria** (The ability to support a force element or force elements in the performance of its missions, functions or tasks for which it is organised or designed to perform, after it is deployed or committed to operations.) are met. AAP 7001.067 (2004)



Approach to be used.

The approach agreed to by the supervisor and new associate supervisor has been broken into the following phases to aid in planning:

- **Phase 1** – Review contemporary defence capability development models, experimentation, interoperability and operational preparedness directives.
- **Phase 2** – Review selected methodologies for systems engineering, experimentation, test and evaluation, preparedness directives, project management and Alliances/Accords for undertaking capability engineering of complex, adaptive military aerospace mission system capabilities intending to be network enabled and used with air armament.
- **Phase 3 –** Conduct a Gap Analysis of current practices.
- **Phase 4** – Propose a code of best practice systems engineering, interoperability and experimentation practices that incorporates modelling and simulation into ground and flight T&E and experimentation frameworks?
- **Phase 5** - Determine insight from case studies of the application of this code of best practice and model to real world avionic mission system upgrades and to network enabled operation experimentation.

RESEARCH THESIS TITLE

The agreed research title is:

"Experimentation of Complex Adaptive Aerospace Mission Capabilities."

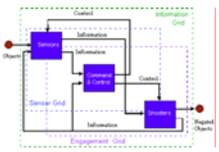
RESEARCH METHODOLOGY

> We are, by all accounts, in the midst of another technological revolution – an information age, a time of near-infinite connectedness. Information storage and retrieval … is the manifest purpose of the digital revolution.
> Relationships in these systems are mutual: you influence your neighbours, and your neighbours influence you.
> All emergent systems are built of this kind of feedback, the two way connections that foster higher-level learning. …
> But it is both the promise and the peril of swarm logic that the higher-level behaviour is almost impossible to predict in advance.
>
> *Johnson (2001) pp 113, 120 & 233*

Delimitations & Assumptions

The research is to be based on unclassified, open-source literature. The conclusions and results of the research should also be unclassified. Other classified work may be generated but is not to be central to the thesis itself.

The extant "systems engineering" framework of the DMO and implementation status determined for contemporary standards of ANSI/EIA STD 632 (1999), ISO 15288 (2002), ISO 12207 (1995) the Capability Maturity Model Integrated model at CMMi (2000) needs to be established to ensure requirements traceability and applicability to ADF aerospace weapon systems.



The recommended systems engineering approach used by INCOSE SE Handbook (2000) and (2005) as well as Hari & Cropley (2007) should be considered.

The proposed standards and best practice should also be suitable, with minimum tailoring, for the development of mission and safety critical software for use with network enabled air armament.

The methodology to address each of the sub-problems is proposed below. The distinguishing characteristics of the research proposed to collect the necessary data are that successful outcomes are based on the approach established by Cropley and Harris (Undated) for EEET 5018 (2006) and Leedy and Ormrod (2001, Table 5-1, p.102).

Sub-Problems

Sub-Problem 1 – What is the utility of contemporary capability development and management models that are in use?

Purpose. Sub-problem needs to explore and interpret current theories for the contemporary standards and best practices in use for improving awareness of confidence in capability development.

Nature of the Process. This sub-problem will be intentionally very diverse, but will require, in the first instance, some description and explanation of the preferred approach.

Methods of data collection Presentations by the candidate at international conferences with ITEA and APSEC 2007 at Tutty (2006) and (2007) respectively have provided a wider than normal broadcast type announcement of the proposed research. Furthermore a Tenix sponsored CEDISC project on related studies was also initiated this year which has resulted already in work by Kennedy (2007) and Nesterov (2007) are also seeking papers being published that will contribute to the body of knowledge needed for this proposal and this particular sub-problem. Extensive literature searches of relevant domains have proved fruitful to date as can be seen from the extent of the new work identified in the References section. Further literature searches and a Descriptive Survey of companies and individuals involved with air armament and NEO to ascertain if any unpublished open-source standards or practices are applicable to the Australian context of mission systems and air armament. The researcher will also need to ensure experienced personnel are drawn from each of the systems engineering and experimentation disciplines that will be engaged in NEO for C2, avionics, M&S and air armament. Since the time of the research proposal the candidate has already had initiated a project with the NATO RTO Flight Test Technical Team (FT3) to address the proposed research (a process that has taken three years too). The NATO RTO FT3 project should ensure a far higher level of engagement with subject matter experts from a more diverse national and cultural perspective now that the candidate is again serving with the RAAF. Ongoing literature searches are needed with the rate of change happening in the field. A Descriptive Survey from companies and individuals involved not only with the hardware and software portions of the avionics but also software engineering in other high risk applications need to be conducted to ascertain via a Content Analysis if any unpublished open-source standards or practices are applicable to the Australian context such as the proposed WDLN at Winters (2007) for the US joint force operations. The sub-problem is also intended to draw on a wide cross-section of stakeholders including the commercial software and gaming industry, users as well as the avionic software engineers themselves to assess risk management implications for complex systems as well as researchers actively involved in complex adaptive systems. The researcher will also need to ensure experienced personnel are drawn from each of the disciplines that will be engaged in the NEO for air armament. The process may be based on changing or unknown variables (how anyone will get users (such as fighter test pilots), technicians, engineers (some of which are designers and others are involved in acquisition and certification), scientists involved in experimentation, testers, the C2 of physically remote Headquarters, commercial software developers and other stakeholders and project managers to agree on the metrics and what they mean should be interesting) for high risk design applications that also has fundamental, ever increasing and considerably more time critical, human interaction with software based systems required. Assessing the personal views of the end users is obviously fundamental to the acceptance of such NEO systems into the ADF.

Form of reasoning used in analysis. Inductive and deductive reasoning will be required.

Communicating findings. Narrative to describe reaction to recommended standards and best practices.

Sub-Problem 2 – What is the suitability of contemporary systems engineering, interoperability and experimentation practices for military aerospace mission system capabilities intending to be network enabled and used with air armament.

Purpose. Sub-problem needs to explore, interpret and build a theory.

Nature of the Process. Sub-problem has potentially unknown variables, an emergent design that is probably context bound in terms of avionic (ie complicated systems) and not yet context bound for NEO systems (ie, complex systems).

Methods of data collection. In parallel with the Descriptive Surveys and research for the other sub-problems, this sub-problem requires that a recommended approach be drawn out of surveys/interviews? The researcher will also need to ensure representative personnel are drawn from each of the disciplines.

Form of reasoning used in analysis. Content Analyses and Inductive reasoning will be required to draw inferences from the literature and surveys.

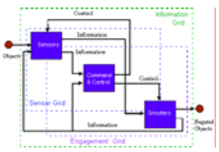
Communicating findings. Narrative.

Sub-Problem 3 – Is a code of best practice that incorporates modelling and simulation into experimentation, ground and flight T&E frameworks achievable now that can serve to give operational staff more confidence in the operational utility of network enabled aerospace mission systems intended for use with air armament?

Purpose. Sub-problem needs to explore, interpret and build a theory for the recommended standards and best practices for experimentation. This will need to be described and then confirmed by Sub-problem 4.

Nature of the Process. This sub-problem will be more focused, but will require in the first instance some description and explanation of the preferred approach.

Methods of data collection In parallel with the surveys and research for the other sub-problems, this sub-problem requires that a recommended approach be drawn out of surveys/interviews? The researcher will also need to ensure representative personnel are drawn



from each of the disciplines. This sub-problem should gain the most insight for the proposal research with the NATO RTO FT3 project initiated by the candidate. The candidate also proposes to undertake several key courses at the National Test Pilot School (NTPS) for contemporary flight T&E applications during which time personnel involved in flight test training will be included in the surveys

Form of reasoning used in analysis. Inductive and deductive reasoning will be required.

Communicating findings. Narrative to describe reaction to recommended standards and best practices.

Sub-Problem 4 – Determine insight from case studies of the application of this code of best practice and model to real world aerospace mission system upgrades and to network enabled operation experimentation / capability models.

Purpose. To devise and implement a validation strategy for recommended models, standards and best practices. This will need to be described and then confirmed.

Nature of the Process. This sub-problem will be more focused, but will require in the first instance some description and explanation of the preferred approach. Quantification will probably need to be undertaken if applicable projects are available within the proposed time line.

Methods of data collection. In parallel with the Descriptive Surveys and research for the other sub-problems this sub-problem requires that a recommended approach be drawn out of Descriptive Surveys/interviews and observation/recording of some Cross-Sectional Studies to obtain quantifiable based on representative case studies or observation of ongoing Accord project during this phase by the P-3 Accord organization with representative stakeholders and users being involved? The methods will depend on extensive personnel involvement in the setting(s) and the pilot/case study projects selected. The researcher will also need to ensure representative personnel are drawn from each of the disciplines to ensure the lessons learned are robust in what will be a phenomenological study. This is quite appropriate as such studies are good at obtaining information about culture Leedy & Ormerod (2001). This subproblem should also gain significant insights from the NATO RTO FT3 Panel project initiated by the candidate. The candidate also proposes to use the NTPS to ensure that the methods proposed are appropriate to flight test.

Form of reasoning used in analysis. Inductive and deductive reasoning will be required.

Communicating findings. Narrative to describe reaction to recommended standards and best practices as well as how statistics will be gained and supporting statistics if the validation phase or test cases can be implemented in the time available.

Research Design.

This analysis clearly indicates a mix of qualitative and quantitative methods are required for researching and collecting data for the problem and the sub-problems posed as follows:

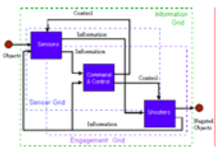
- **Sub-Problem 1.** Literature search and qualitative surveys/interviews will be necessary. Tutty (2006) and (2007) presentations at the 14th ASC ITEA Symposium, DEFNET 2006 and the inaugural APSEC 2007 sought interest in the proposed research.

These presentations highlighted the historical context with the likes of Blanchard and Fabricki (2006), ALWI II (2004), Alford (2001), Filmer (2003), Mayer (2007), Welch (2006) and the numerous outstanding papers at the 12th International Command and Control Research and Technology Symposium (ICCRTS) typified by Hiniker (2007). The application of Service Oriented Architectures inter alia ALWI II (2004), Mayer (2007), Society of Automotive Engineering Standards (2007) and MIL-STD-3014 (2004) will need to be addressed. Most recently the candidate successfully had an Australian representative attend the latest Society of Automotive Engineers AS-1 meeting, MacIntosh (2007) wherein very valuable insights into current and future weapons integration standards are being proposed and agreed. Assessing the implications of developments with ISO/IEC 17025 (1999), Greenlee (2004), Rutan (2007) and Moon et al (2006) as well as some of the other referenced works would be undertaken in this phase. Qualitative surveys will be conducted with specific personnel and groups of representative, experienced network enabling software personnel and observation of operations with aircraft avionic software development to determine suitability. Layton (2005) and Alberts & Hayes (2007) provide by far the best contexts for these surveys. Woitalla (2006) and Kuzmick (2006) also provide views on weapon data link networks. Specifically support from CDE Aerospace Development, DMO, Commonwealth P-3 Integration, Test & Training Facility and other software support facilities will be solicited for qualitative face-to-face interviews and questionnaires. The limited number of organisations available in Australia is the major area of concern with the sample size. The specific issues and recommendations raised in the audit of DMO and ADF T&E practices at ANAO (2002) will also be reviewed to ensure that where ever possible they can be addressed. The work of Ball (2004), Ormerod, (2005), Gisogono (2007), Hanlon (2007) and Watts (2002) to characterise the impact of power laws, critical/tipping points, metastability of complex adaptive systems/networks for future mission systems and determine the ways to optimally conduct experimentation and V&V with a whole of life approach.

- **Sub-Problem 2**. Essentially the same as Sub-Problem 1, but focus on systems engineering, experimentation and end user communities. Note that this sub-problem will be explored in parallel with Sub-Problem 1 but it may not be possible and/or practical with the different communities involved and the possibly significantly different outcomes to have meaningfully done them together. Use of the NATO RTO and TTCP to coordinate the proposed model will be investigated with DSTO and the ADF.

- **Sub-Problem 3.** Qualitative surveys will also be required with specific personnel and groups of representative, experienced avionics and avionic software personnel and observation of operations with avionic software development to determine the range of experimentation needed and there suitability as a benchmark for a code of best practice. Specifically support from Commonwealth AOD, P-3, F-111 and F/A-18 avionic software support facilities, contractors, experimental scientists, testers and airworthiness authorities will be solicited for qualitative face to face interviews and questionnaires. The limited number of organisations available in Australia is again a major area of concern with the sample size. This Sub-Problem warrants the time to invest in asking key overseas organizations the same questions in the hope answers will be received to meet the schedule. Qualitative surveys will also be required with the identified wider target audience (end users, DSTO, JEWOSU, 87 SQN, key international agencies and commercial software developers being most notable) and an ethnography (based on more applications in recent years Cropley & Harris (Undated) and Leedy and Ormrod (2001, p.151)) is recommended to gain insight into the cultural aspects of ADF users acceptance of the best practice options and metrics to establish avionics suitability against agreed operational requirements of NEO for air armament. Use of the NATO Research & Technology Organisation (RTO) has already been agreed in principle and The Technical Cooperation Program (TTCP) to coordinate the proposed code of best practice will be investigated with DSTO and the ADF. The candidate also proposes to undertake several key courses at the National Test Pilot School (NTPS) for contemporary flight T&E applications during which time personnel involved in flight test training will be included in the surveys. Funding of this approach will be sought primarily via the ADFs Engineers Professional Development scheme and potentially from the ADF, DSTO, US Office of Naval Research (ONR), the USAF Asian Office of Aerospace R&D (AOARD) in Japan as well as the University. Layton (2005) should provide a good basis for survey respondents to gain an understanding of the issues. The development and discussion on a hypothetical pilot/case study will be useful to establish the practicality of quantifying best practice and metrics for Sub-problem 4.

- **Sub-Problem 4.** Qualitative surveys will need to be conducted with specific and groups of representative, experienced personnel and observation of operations would need to be observed to determine suitability. The research design should also involve quantitative descriptive surveys of a number of personnel from each stakeholder discipline for the pilot/case study. The major concern is the ability to gain statistically valid information with the limited and parochial industry base in Australia. Quantitative trials of software support facility personnel and processes may need to be designed in a PhD program, potentially using the P-3 Operational Mission Simulator and the "Aerospace Battlelab Centre" as proposed at Farrier et al (2004), to explore whether metrics are useful and can be met across all disciplines to gain statistically valid information on system performance. Some instrumentation could also be used to document performance as well as accuracy of any assumptions in flight/mission simulators and or T&E ground and/or flight tests. The research design could involve case studies of a number of personnel from each discipline with several project analyses/predictions. Originally it was hoped that the Project Air 5276 schedule would enable systems being planned for Capability Assurance Program (CAP 2) for upgrade of the AP-3C Data Management and Stores Management Systems would have timelines conducive to use of the Systems Engineering Laboratory as part of the case studies. The slow progress of the CAP program through the higher level Defence Committees, however, already makes such a proposal tenuous as the CAP 2 program has not achieved First Pass Approval! The candidate expects now that comparisons between ongoing projects will be the means to validate the code of best practice. Given that Tenix FX0119A001A-20 (2007) has been published, it will be used as the framework until the code of best practice is developed for conduct of the Cross Sectional Study. Note that given the wide ranging strategies for P-3 Accord projects an experimental approach may be able to be formulated to investigate numerous dependent variables with the systems engineering and experimentation approaches instituted by the IPT! This subproblem should also gain significant insights from the NATO RTO FT3 Panel project initiated by the candidate and from TTCP involvement. The candidate also proposes to use NTPS to ensure that the methods proposed are appropriate to flight test. Funding of this will be sought via US ONR and the USAF AOARD as well as the University. The candidate has also sponsored, via Tenix and now the RAAF via the Concept to Creation (C2C) Program of the Northern Advanced Manufacturing Industry



Group (NAMIG)) an *Experimental Genesis Uninhabited Air Vehicle Challenge* with several senior high schools participating, C2C (2007). Concept to Creation (C2C Program of the Northern Advanced Manufacturing Industry Group (NAMIG)) an Experimental Genesis Uninhabited Air Vehicle Challenge with several senior high schools participating, C2C (2007).

RESEARCH SCHEDULE

Plans are useless, planning is indispensable.

General Dwight Eisenhower, Supreme Allied Commander Europe, WW II, US Army, later US President

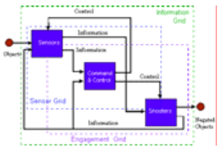
The proposed schedule for this research is shown in Annex A.

RISKS

“The ‘warfighter’ in the field, our [true] customer, has four priorities, in this order:
1. To keep himself alive.
2. To keep his buddy alive.
3. To accomplish the mission or complete the operation.
4. To follow prescribed policies and procedures.
Our job is to make compliance with policies and procedures transparent so the warfighter doesn't have to worry about it at all.”

VADM Herb Brown, USN (Retd)

One of the original risks as mentioned already with the Research Proposal of 30 August 2007 is that the validation of the models was originally relying on Defences’ delivery schedules for the Commonwealth of Australia (2006) CAP 2 initiatives. This is has been ameliorated as discussed earlier by the monitoring the performance of other project activities. The Tenix-C2C Program *Genesis Uninhabited Air Vehicle Challenge* with several senior high schools participating, C2C (2007). Concept to Creation (C2C Program of the Northern Advanced Manufacturing Industry Group (NAMIG)) an Experimental Genesis Uninhabited Air Vehicle Challenge with several senior high schools participating, C2C (2007). This may present an opportunity to investigate the proposed code of best practice, albeit with high school student who may not have the maturity or cognitive abilities developed to be fully representative. The major remaining risk for research such as this is that full and frank response to the Descriptive Surveys will not be provided by other organisations and companies. This risk has now been reduced and in conjunction with the proposed use of NTPS has been minimised now that the candidate does not work for industry. This risk will need to be explored further with DASI and CEDISC possibly serving as an intermediary. Support for use of the NATO RTO, NTPS and TTCP to coordinate and investigate the proposed code of best practice and model will be sought from the ADF and DSTO.



PROPOSED TABLE OF CONTENTS

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5.2 Net-ready KPPs and other information certification conundrums
5.3 Complex adaptive systems characterisation

CHAPTER 6 - Code of Best Practice and Model Validation and Verification

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6.2 Experimentation COBP V&V
6.3 Capability Model V&V

CHAPTER 7 – Case Studies

CHAPTER 8 - Conclusions and Further Work

8.0 Background
8.1 Conclusions
8.2 Further Work

REFERENCES

APPENDICES

GLOSSARY

All terms used in this research proposal, unless explicitly included as footnotes, are covered by the Glossary and Acronyms provided at Tutty (2005).

REFERENCES[12]

> We are in the midst of another technological revolution – an information age, a time of near-infinite connectedness. Relationships in these systems are mutual: you influence your neighbours, and your neighbours influence you.
> All emergent systems are built of this kind of feedback, the two way connections that foster higher-level learning. … But it is both the promise and the peril of swarm logic that the higher-level behaviour is almost impossible to predict in advance. *Johnson (2001)*

AAP 1000, *Air Power Manual*, Royal Australian Air Force, Commonwealth of Australia, Canberra, Australia.

AAP 7001.053 (AM1), 2005, *Technical Airworthiness Management Manual*, 6 January 2005, Royal Australian Air Force, Commonwealth of Australia, Canberra, Australia. " [Online, accessed 19 July 2007],
URL: http://www.defence.gov.au/dgta/Publications/7001053AM1/prelim.pdf

AAP 7001.054 (AM1), 2004, *Airworthiness Design Requirements Manual*, 23 Feb 2004, Royal Australian Air Force, Commonwealth of Australia, Canberra, Australia. [Online, accessed 19 July 2007], URL: http://www.defence.gov.au/dgta/Publications/7001054/prelim.pdf

AAP 7001.067, 2004, *Air Armament Manual (Draft May 2004)*, Royal Australian Air Force, Commonwealth of Australia, Canberra, Australia.

Alberts, Dr D.S, 2007, *The Future of C2: Agility, Focus and Convergence*, 12th International Command and Control Research and Technology Symposium (ICCRTS) "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],
URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Alberts, Dr D.S. and Hayes, Dr R.E., 2005, *Power to the Edge: Command… Control… in the Information Age*, 3rd Printing April 2005, Command and Control Research Program, [Online, accessed 31 December 2006].
URL: http://www.dodccrp.org

Alberts, Dr D.S. and Hayes, Dr R.E., 2007, *Planning: Complex Endeavours.* Command and Control Research Program, April 2007 [Online, accessed 15 July 2007].
URL: http://www.dodccrp.org

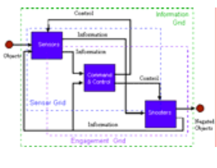
Alford, L.D., 2001, The Problem with Aviation COTS, *IEEE AES Systems Magazine*, February 2001, pp 3-37.

ALWI-2, 2004, *Final Report, Follow-up Study, Aircraft, Launcher & Weapon Interoperability (ALWI-2)*, NATO Air Force Armaments Group (NAFAG), Air Group 2 on Air Weapons, NATO Industrial Advisory Group (NIAG), AC/224(AG/2)D(2004)0001, 7 April 2004.

ANAO, 2002, *Test and Evaluation of Major Defence Equipment Acquisitions*, Audit Report No 30, Australian National Audit Office, Commonwealth of Australia, Canberra, Australia.

Anderson, B., Boxer, B., and Chen, B., 2007, *Model Based Analysis Reveals Systems-of-Systems Risks of NATO*, SEI Poster Presentation to 8th NDIA Science & Engineering Conference, June

12 The references in **bold** are the key references in the field. The potential application of Experimentation and M&S to complex systems behaviour and NCO is certainly one of the hot topics of research. The method of referencing some ADF and military specifications has also been simplified in response to considerable feedback from (intended) defence researchers to simplify the references to familiar engineering standards and ADF policy and instructions.



2007, [Online, accessed 9 July 2007] URL: http://www.ndia.org/Content/ContentGroups/Divisions1/Science_and_Engineering_Technology/Anderson.pdf

ANSI/AIAA G-043-1992, *Guide for the Preparation on Operational Concept Documents*; American Institute for Aeronautic & Astronautics, Washington, USA.

ANSI/EIA STD 632, 1999, *Process for Engineering a System*, American National Standards Institute / Electronic Industries Association Standard 632, Washington, USA.

ASCENG Air Armament File, 2002, *Air Armament File – the Anniversary Edition*, ASCENG, Department of Defence, RAAF Base Edinburgh, Australia.

ASIC, 2007, *Index of ASCC Air Standards*, Air and Space Interoperability Committee (ASIC, formerly the ASCC) Website, [Online, accessed 27 January 2007].

URL: http://www.airstandards.com/ascc/index.php

Aslaksen, Dr E.W., 2006, *The Boundaries of Systems Engineering*, SETE 2006 Keynote Address, SESA Newsletter No. 41, September 2006

AS/NZ 4360, *Risk Management*, Commonwealth of Australia, Canberra, Australia.

Ball, Dr P. 2004. *Critical Mass, How One Thing Leads to Another.* William Heinemann, USA

Barnett, T.P.M., 2004, *The Pentagon's New Map: War and Peace in the 21st Century*, Putnam, USA [Online, accessed 30 January 2005].
URL:http://www.thomaspmbarnett.com/published/pentagonsnewmap.htm

Belcher, Prof R., 1996, *Systems Engineering Foundations*, Keynote Address at SE'96 Melbourne 17 October 1996, SESA Newsletter No. 36, March 2005

Ben-Asher, J.Z, Zack, J., Prinz, M., 2000, *Development Program Risk Management: Principles and a Case Study*, American Institute of Aeronautics and Astronautics, Inc

Bentley, Air Commodore G. RAAF, 2006, *RAAF Precision Strike Programs Overview:* Presentation by Air Attaché, Australian Embassy to Precision Strike Symposium, 19 Oct 2006, [Online, accessed 19 July 2007], URL: http://www.dtic.mil/ndia/2006psa_psts/bentley.pdf

Blanchard, S.B. & Fabrycky, W.J. 2006, *Systems Engineering & Analysis*, 4th Ed, Prentice Hall International Inc, USA.

Bock, P., 2001, *Getting it Right: R&D Methods for Science & Engineering*, Academic Press

Bowlds, MG T.F., 2007,*"Solutions to Current Challenges": FY07-FY09*, USAF, Commander, Air Force Research Laboratory Presentation to the Pacific Theatre Operational Science and Technology Conference, Hawaii, 3 April 2007. [Online, accessed 25 August 2007].
URL: http://www.dtic.mil/ndia/2007pto/Wednesday/MajGenBowlds.pdf

Bowley, D, 2007, GUIDEx – From experiments and Campaigns to Integrated Analytical & experimentation Programs, DSTO February 2007

Borgu, A., 2003, The Challenges and Limitations of Network Centric Warfare" – The initial views of a NCW Sceptic, *ADF NCW Conference 17 September 2003*, Australian Strategic Policy Institute, Canberra, Australia

Boyd, Col J.R., 1987, *A Discourse on Winning & Losing*, Air University Press, Montgomery, Alabama, USA, August 1987. [Online, accessed 10 January 2007].

URL: http://www.d-n-i.net/fcs/comments/c199.htm

Brunson, N, et al, 2002, *A World of Standards*, Oxford University Press, UK.

Burita, Prof L., Ondryhal, V, 2007, *COTS Software for the Net-Centric C2 Decision Support and Knowledge Management.* 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Cannon, P, 2004, *Technologies for Interoperability*: Foundation Initiative 2010, [Online, accessed 25 January 2005]. URL: http://www.dtic.mil/ndia/2001systems/cannon.pdf

Cary, A., Bower, J., Wesley, L., A Different Approach to Assessing the Uncertainty Associated with a Stores Trajectory**,** *14th ASC Symposium International Test and Evaluation Association*, Ft Walton Beach FL, April 2006.

Cebrowski, VADM A. K., USN, and Garstka, J. J., 1998, Network Centric Warfare: Its Origin and Future, *Proceedings of the Naval Institute* 124, Jan 1998, 232-35. [Online, accessed 10 May 2004]. URL: http://www.usni.org/Proceedings/Articles98/PROcebrowski.htm

Chaturvedi, A. Cibulskis, M. Tham, Y.L. Armstrong, B. Snyder, D. Everson, P. Shreve, J., 2007, *Integrating, Planning & Experimentation*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Chedister, Maj Gen R, 2005, Keynote Address, Precision Strike Association Summer PEO Forum, Ft Walton Beach, FL, 27 July 2005

Chessell, Dr I, 2006, The world is flat: The Impact of Network and Data Management Technologies, *Presentation to Tenix Engineering Conference*, Adelaide Convention Centre, South Australia, September 2006

Chicoine, CAPT M, 2007, *Briefing to the Precision Strike Association*, US Joint Forces Command, [Online, accessed 15 January 2007]. URL: http://www.dtic.mil/ndia/2004expwarfare/2004expwarfare.html

Christensen, C.M. 1997, *The Innovator's Dilemma*, Harper Business, USA.

Christianson, P., 2007, *Information Operations and the NetReady Key Performance Parameter in US DoD Systems Acquisition & T&E*, Invited Paper Information, Decision and Control IDC Conference 2007, Adelaide, South Australia February 2007.

Collignon, S., Cook, Prof S., 2004, *On Identifying a Methodology for Integration of COTS products in Research*, SETE 2004, Adelaide South Australia

Curr, WGCDR A., 1993, *Weapons Win Wars*, Air Power Studies Centre Paper 17, Canberra, ACT [Online, accessed 15 January 2007]. URL: http://www.defence.gov.au/raaf/airpower/html/publications/papers/apsc

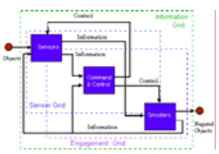
Clark, M. & Moon, T. 2003, Interoperability for Joint & Coalition Operations, *ADF Journal,* Pp 23-36, Oct/Nov 2001

Clausewitz, Carl von, 1832, *Vom Kriege (On War),* Dümmlers, Berlin, Germany. [Online, accessed 12 December 2004]. URL: http://www.clausewitz.com/CWZHOME/FAQs.html

Clippinger, J. H., 2007, *Human Nature and Social Networks,* 12th ICCRTS "Adapting C2 to the 21st Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Cloud, D, & Rainey, L, 1998, *Applied Modelling & Simulation: An Integrated Approach to Development & Operation*, McGraw-Hill Companies, USA



CMMi, 2000, *Carnegie Mellon University Software Engineering Institute (SEI) Capability Maturity Model Integration (CMMI®) for Systems Engineering Product & Process Development*, Continuous Representation

Collinson, R.P.G. 2002, *Introduction to Avionic Systems*, Kluwer Academic Publishers, UK.

Common Data Link, 2004, *Configuration Profile for End-to-End Interoperability among Naval CDL Systems*, Draft Version 9, 18 May 2004.

Commonwealth of Australia, 2002, *ADF Standardisation Manual*, STANMAN, Department of Defence, Canberra, Australia.

Commonwealth of Australia, 2004, *Australian Defence Force Doctrine Publication – D.3.1 – Enabling Future Warfighting: Network Centric Warfare (Capstone Doctrine ADDP-D.3.1)*, Department of Defence, Canberra, Australia.

Commonwealth of Australia, 2005, *Australian Strategic Defence Contracting (ASDEFCON)*, Department of Defence, Canberra, Australia. . [Online, accessed 12 July 2007].

URL: http://www.defence.gov.au/dmo/DMO/function.cfm?function_id=45

Commonwealth of Australia, 2006, *Defence Capability Development Manual*, Department of Defence, Canberra, Australia. [Online, accessed 12 July 2007]. URL: http://www.defence.gov.au/capability/common/_pubs/dcdm%20preface%20and%20toc.pdf

Commonwealth of Australia, 2006a, De*fence Capability Plan 2006 - 2016*, Department of Defence, Canberra, Australia. [Online, accessed 12 December 2006].

URL: http://www.defence.gov.au/Capability/docs/Public_DCP_2006-16.pdf

Commonwealth of Australia, 2007, *Australian Defence Force Network Centric Warfare Roadmap*, Department of Defence, Canberra, Australia. [Online, accessed 12 July 2007].

URL: http://www.defence.gov.au/capability/ncwi/docs/2007NCW_Roadmap.pdf

Commonwealth of Australia, 2007a, *Australian Defence Force Doctrine Publication – D.3 – Joint Operations for the 21st Century (Capstone Doctrine ADDP-D.3)*, Department of Defence, Canberra, Australia. [Online, accessed 21 July 2007].

URL: http://www.defence.gov.au/publications/FJOC.pdf

Corbin, R.D., Dunbar, C.B., Payne, M, Zhu, Q., *Tailored Information Delivery and Service for Network C2 Support*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007].

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Corley, Dr J.D., *War Winning Capabilities – On Time, On Cost, Investments in Air Armament at Eglin AFB*, Presentation to 2006 Air Armament Symposium, Ft Walton Beach, FL, USA

Craig, R.D. & Jaskiel, S.P., 2002, *Systematic Software Testing*, Artech House Publishers, USA.

Crebolder, J.M. Cooper-Chapman, C.S., Hazen, M.G., Corbridge, C., 2007, *Assessing Human Performance in a Distributed Virtual Battle Experiment*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Cropley, Dr D.H., Harris, M.B., Undated Paper, *Too Hard, Too Soft, Just Right … Goldilocks and Three Research Paradigms in SE [Systems Engineering]*, Paper distributed with EEET 5108 (2006), Systems Engineering and Evaluation Centre, University of South Australia

Crouch, Dr V. 2007, *Strategic RDT&E Infrastructure Planning – A Whole of Nation Issue*, IDC 2007 Conference, Hilton, Adelaide, South Australia, February 2007

C2C , 2007, *Tenix – C2C Genesis Experimental Uninhabited Air Vehicle Proposal*, V1, 15 August 2007 [be provided Online shortly], URL: http://www.concept2creation.com.au/index.php

Daniels, D., Myers, R., Hilton, A., 2003, *White Box Software Development*, Published in Current Issues in Safety Critical Systems, Springer-Verlag, London. Pp 119-136

DEF (AUST) 5664, 1995, *Work Breakdown Structures For Defence Materiel Projects - Policy And Guidance*, Department of Defence, Canberra, Australia.

DEF (AUST) 5679, 1992, *Procurement of Computer-Based Safety Critical Systems*, Department of Defence, Canberra, Australia.

DEF STAN 00-970, 1999, *Design and Airworthiness Requirements for Service Aircraft*, UK Defence Standardisation Agency, UK.

Defence White Paper, 2000, *Our Future Defence Force*, Department of Defence, Canberra, Australia. [Online, accessed 12 December 2006]. URL: http://defweb.cbr.defence.gov.au/cd/pubs

Dent, H.S. Jr, 2005, *The next great bubble boom: how to profit from the greatest boom in history*, Schwartz Publishing, Melbourne Australia

De Oliveira, Col. M.F., 2007, *C2 at the Edge of Chaos: The Real Transformation to Enable* Network Warfare, 12th ICCRTS "Adapting C2 to the 21st Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Deptula, Lt Gen D, 2006, Capability *Insight, Maintaining air dominance in the Pacific*, US PACAF Interview Defence Today IV 2006, [Online, accessed 30 June 2007].

URL: *http://www.ausairpower.net/DT-Deptula-IV-06.pdf*

DI(AF) OPS 1-19, 2002, *Aviation Risk Management*, Department of Defence, Canberra, Australia.

DI(G) OPS 2-2, 2001, *Australian Defence Force Airworthiness Management*, Department of Defence, Canberra, Australia.

Dodds, P.S., Watts, D.J., Sabel, C.F., 2003, Information exchange and the robustness of organisational networks, *Publication of the National Academy of Sciences*, 14 October 2003 Vol 100 no. 21

Donnelly, B. P., Bolia, R.S., & Wampler, J.L., 2007, *Capturing Commander's Intent in User Interfaces for Network-Centric Operations*, 12th ICCRTS "Adapting C2 to the 21st Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Donnelly, J.J., 2000, *Best Value Solutions: A Systems Engineering Perspective*, SESA 2001, © Lockheed Martin Corporation

Dutchyshyn, Col H, 2005, *Implementing the JBMC2 Roadmap – A JSSEO Perspective*, Joint Single Integrated Air Picture Systems Engineering Organisation presentation to NDIA NCW Conference, 23 March 2005, [Online, accessed 9 January 2007],

URL: http://www.dtic.mil/ndia/2005netcentric/wednesday/dutchyshyn.pdf

EEET 5108, 2006, *Research Methods in a Multidisciplinary Environment – Course Information*, School of Electrical and Information Engineering, University of South Australia

Elliot, S., 2000, Incremental Decisions in a Complex World, *IEEE Engineering Management Review*, 4th Quarter 2000, p 104

Farrier, A SQNLDR, Appla, D & Chadwick, J. 2004, *As Easy as ABC*, ADF Experimentation Symposium, Defence Science & Technology Organisation, June 2004

Filmer, S.W., 2003, 'Open Systems Avionics Architectures Considerations For The Australian Defence Force', *IEEE AES Systems Magazine*, Institute of Electrical and Electronic Engineers Inc, September 2003

Fong, G. Oh, K., *An Experiment in Machine-Augmented Sensemaking in Intelligence Analysis,*12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Foote, S., Scarano, J. Foote, S., Modeem, R., 2007, *The U.S. Air Force Technical Implementation Architecture,* 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Forlani, D., 2002, Risk & Rationality: The influence of Decision Domain & Perceived Outcome Control of Managers High Risk Decisions, *Journal of Behavioural Decision Making*, 15: 125-140, Wiley Interscience 8 February 2002

Forrester, Prof J.W., 1969, *Urban Dynamics*, The MIT Press, Massachusetts, USA. See also [Online, accessed 19 August 2007], URL: http://www.systemdynamics.org/

Fuller, J.F.C., 1926, *The Foundations of Science and War*, Hutchinson and Company, London, UK

GAO-04-858, *2004, Defense Acquisitions: The Global Information Grid & Challenges Facing its Implementation,* US Government Accounting Office Report to Subcommittee on Terrorism, House of Representatives, US Government, July 2004, [Online, accessed 10 December 2004].

URL: http://www.gao.gov/cgi-bin/getrpt?/GAO-04-858

Garstka, J.J. 2000, *Network Centric Warfare: An Overview of Emerging Theory*, Joint Staff Directorate for C4 Systems, US DoD, Washington, USA [Online, accessed 10 May 2004].

URL: http://www.mors.org/publications/phalanx/dec00/feature.htm

Gartska, J.J., 2005, *Fighting the Networked Force*, Presentation to the NDIA Network Centric Operations Conference, 21 March 2005, [Online, accessed 15 July 2007].
URL: http://www.dtic.mil/ndia/2005netcentric/2005netcentric.html

Gleick, Dr J, 1987, *Chaos – Making a new science*, Penguin Books, USA

Greenlee, Dr D, 2004, *T&E As An Element of SE And Vice Versa: It's Only Fair Play*, SETE Conference, 8 November 2004, Adelaide, SA

Gregory, D.A., 2004, The Plug & Play Weapon, *Royal United Services Institute for Defence and Security Studies Publication*, Issue 7, 2004 [Online, accessed 31 December 2004].

URL: http://www.sovereign-publications.com/wds-7-articles.htm

Grisogono, A and Ryan, A., 2007, *Operationalising Adaptive Campaigning*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

GUIDEx (2006), *TTCP Guide for Understanding and Implementing Defense Experimentation (GUIDEx)*, The Technical Cooperation Program, [Online, accessed 15 July 2007].
URL: http://www.dtic.mil/ttcp/guidex.htm

Hall, Dr W., 2006, Why Tenix Thinks S100D is so important, *Presentation to Tenix Engineering Conference,* Adelaide Convention Centre, South Australia, September 2006

Hanlon, Dr B, 2007, *Establishing Fair Principles of Cooperation for Complex Civil-Military Operations: DSTO/AS*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Harmon, M, 1997, *Entropy Based Warfare: A Unified Theory for Modeling the Revolution in Military Affairs*. Booz-Allen & Hamilton, USA

Hari, Dr A., & Cropley, Dr D., 2007, *Research on Agile Systems Engineering for Creative Anti-Terror Solutions*, Presentation to University of SA SEEC & DASI Group Meeting for Technion TAE Report No. 974 of June 2007, Israel Institute of Technology, Haifa, Israel, 28 July 2007

Hayes Dr R.E., Alberts, Dr D.S. 2002, *Experimentation; Code of Best Practice*, Command and Control Research Program, [Online, accessed 1 September 2006]. URL: http://www.dodccrp.org

Heuer, R Jr, 2003, The Psychology of Intelligence Analysis, Cwenter for the Study of Intelligence, CIA, 3rd Edition, Washington DC ISBN 1920667000

Hensley, G., 2007, *Alliance Base Defence and the P-3 Accord*, Master of Project Management Dissertation, School of Natural and Built Environments, University of South Australia.

Hiniker, Dr P.J., 2007, *Operational Replanning with User Defined Operational Picture: Warfighting Experiment & Operational Assessment Plan*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Hobbins, Lt Gen T, 2004, *Deliberate Force Projection – Integrating Weapons to yield the desired effect*, Presentation to 30th NDIA Symposium, 12/13 October 2004, Eglin AFB, FL

Hodermarsky, Dr G.T., 2007, *(Unintended) Effects Based Operations: Dealing with Secondary Effects*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Hudry, W., Statistical Methodology for Development of Adequate Confidence Testing for Systems under Constraining Conditions and Resource Limitations to provide for Optimal Design, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Hutchins, S.G., Timmons, R.P., 2007, *Radio Interoperability: There is More to it Than Hardware.* 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

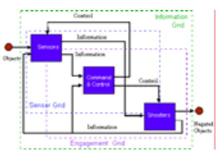
URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

IEC 615508, 2004, *Functional safety of electrical/electronic/programmable safety-related systems*, International Electrotechnical Commission, [Online, accessed 15 December 2004].

IEEE 1471, 2000, *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems, IEEE, USA.* [Online, accessed 19 July 2007],

URL:http://standards.ieee.org/reading/ieee/std_public/description/se/1471-2000_desc.html

Ilachinski, Dr A., 2004, *Artificial War – Multi-agent-Based Simulation of Combat*, World Scientific Publishing Co, Singapore



INCOSE SE Handbook, 2000, *Systems Engineering Handbook*, International Council for Systems Engineering, Version 2.0 Edited by R.B. Wray, Seattle, WA, USA [Online, accessed 19 July 2004], URL: http://www.iec.ch/zone/fsafety/fsafety_entry.htm

INCOSE SE Handbook, 2006, *Systems Engineering Handbook*, International Council for Systems Engineering, Version 3, Seattle, WA, USA

ISO 9001:2000, 2000, *Quality Management Systems*, International Organization for Standardization.

ISO/IEC 12207, 1995, *Software Life Cycle Processes*, International Organization for Standardization and the International Electrotechnical Commission [Online, accessed 15 December 2004]. URL: http://www.12207.com/

ISO/IEC 15288, 2002, *System Life Processes*, International Organization for Standardization and the International Electrotechnical Commission [Online, accessed 15 December 2004].

URL: http://www.15288.com/

ISO/IEC 17025, 1999, *General Requirements for the Competence of Testing & Calibration Laboratories*, International Organization for Standardization and the International Electrotechnical Commission [Online, accessed 15 December 2004].

URL: http://www.fasor.com/iso25/ is extremely useful and proves excellent links to the myriad of other standardisation authorities, text provided courtesy http://www.omnex.com/Standards/iso_17025/iso_17025.html

Johnson, Dr S, 2001, *Emergence – The connected lives of Ants, Brains, Cities, and Software*, Scribner, New York, New York.

Kasera, S, Narang, N & S, 2007, *Communication Networks – Principles and Practice*, McGraw Hill, Companies, Inc, New York, NY.

Kennedy, D., Nesterov, Dr S., 2007, *Impact Analysis of Software Change for Mission Critical Systems*, SETE Proposed Paper, University of South Australia

Kew, M., 2006, *Extending decision theory using the ethics of R.M. Hare and K. Popper*, Research Proposal submitted for a Doctorate of Philosophy, 6 May 2006, University of South Australia, Mawson Lakes, SA, 5095

Kew, M., 2006a, *Decision Framework*, Unpublished paper being prepared for a Doctorate of Philosophy, 27 July 2006, University of South Australia, Mawson Lakes, SA, 5095

Kleinburg, J, Undated, *Small World Phenomena and the Dynamics of Information*, Dept of Computer Science, Cornell University, Ithaca, NY.

Kline. S.J., 1995, *Conceptual; Foundations of Multidisciplinary Thinking*, Stanford University Press, Stanford, California

Kneidal, T.A., and Buchholz, H., 2001, STANAG 5066 – Flexible Software/Hardware Solution for the new NATO HF-communications Protocol, *IEEE*, 0-7803-7225-5/01, 2001.

Knight, Dr., 2004, *An Evolutionary Framework for Experimental Innovation*, ADF Experimentation Symposium, Defence Science & Technology Organisation, June 2004

Kopp, Dr C., 2003, Network Centric Warfare, *Defence Today Magazine*, 2003, p 28-34 [Online, accessed 10 May 2004]. URL: http://www.ausairpower.net/NCW.pdf

Kopp, Dr C. 2004, *Myths, Facts and the RAAF Force Structure, Air Power Analysis 2004*, 19 November 2004, [Online, accessed 15 January 2004].

URL: http://www.ausairpower.net/APA-2004-04.html

Kopp, Dr C., 2006, *Attaining Air Superiority in the Region: Testing the Evidence*, Inquiry into Australian Defence Force Regional Air Superiority, 15 May 2006, [Online, accessed 15 July 2007]. URL: http://www.aph.gov.au/house/committee/jfadt/adfair/subs.htm

Kunreuther, H., Novemsky, N., Kahneman, D., 2001, Making Low Probabilities Useful, *The Journal of Risk and Uncertainties*, Kluwer Academic Publishers, The Netherlands, 23:2; 103-120

Kuzmick, J.J., 2006, *Multi-Mode Precision Strike Weapons - The answer for mobile targets?* Presentation to Precision Strike Symposium, 19 Oct 2006, [Online, accessed 19 July 2007],

URL: http://www.dtic.mil/ndia/2006psa_psts/kuz.pdf

LAI, 2004, *Lean Aircraft Initiative: Position Paper on Government Use of Lean Enterprise Self-Assessment Tool (LESAT) for Benchmarking (Comparison of LESAT and CMM^R/CMMI^{SM} for Comparing Companies)*, Software Engineering Institute, USA [Online, accessed 15 January 2004]. URL: http://www.sei.cmu.edu/cmmi/publications/comparison.doc

Lane, M. 2000, 'Predicting the Reliability and Safety of Commercial Software in Advanced Avionic Systems, *The 19th Digital Avionics Systems Conferences*, P. 4E4/1 -4E4/8 vol.1.

Layton, Group Captain P., 2003, *Towards Managing Uncertainty: Coupling Experimentation with Rapid Prototyping*, Aerospace Centre Working Paper April 2003, Canberra, ACT [Online, accessed 15 January 2007].
URL: http://www.defence.gov.au/raaf/airpower/html/publications/papers/apsc

Layton, Group Captain P., 2003a, *Accepting Uncertainty: A Contemporary Methodology for Capability Development*, Air Power Development Centre Working Paper 15, Canberra, ACT [Online, accessed 15 January 2007].
URL: http://www.defence.gov.au/raaf/airpower/html/publications/papers/apsc

Layton, Group Captain P., 2005, *Making Use of Uncertainty: A Different Approach for Capability Development*, Australian Defence Force Journal, Issue NO 167, Sept 2005, Canberra, ACT pp 9-22 [Online, accessed 15 July 2007].
URL: http://www.defence.gov.au/publications/dfj/adfj167.pdf

Leedy, P.D, & Ormrod, J.E., 2001, *Practical Research: Planning & Design*, 7th Ed, Prentice-Hall, Inc, United States of America

Lichtblau, D.E. Wartik, S.P., 2007, *Cross-Domain Ontology Resolution in Net-Centric Command and Control*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Lidwell, L. Holden K., Butler, J., 2005, *Universal Principles of Design: 100 ways to Enhance Useability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design*, Rockport Publishing Inc, Massachusetts, USA, ISBN 1-59253-007-9

Lough, Dr R, 2007, *Current Theatre Environment - An Australian Perspective*, Chief Defence Scientist DSTO Presentation to the Pacific Theatre Operational Science and Technology Conference, Hawaii, 3 April 2007. [Online, accessed 25 August 2007].
URL: http://www.dtic.mil/ndia/2007pto/Tuesday/DrRogerLough.pdf

MacIntosh, C, 2007, *Report on SAE AS1 Meeting 9-13 July 2007*, Tenix Defence Holdings, 21 July 2007

Mark, Dr A., Findlay Dr D., Meilunas, VanderVliet, G., 2005, Collaborative Simulation and Testing Using High-Performance Computing, *ITEA Journal*, June/July 2005 pp 27-33

Matheus, C.J. Ulicny, B., 2007, *On the Automatic Generation of an OWL Ontology based on the Joint C3 Information Exchange Data Model.* 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Mayer, G, 2006, *Strike Planning Enterprise Service Oriented Architecture*, Presentation to Precision Strike Symposium, 19 Oct 2006, [Online, accessed 19 July 2007],

URL: http://www.dtic.mil/ndia/2006psa_psts/mayer.pdf

McCaskill, L. P, 2007, *Beyond PowerPoint Deep: a Concept of Operations for Implementation Net-Centric Warfare,* 12th ICCRTS "Adapting C2 to the 21st Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

McEver, Dr J.G., Martin, D.M. Hayes, Dr R, 2007, *Operationalizing Agility*, Keynote Address at the 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

McKee, M., Crashed spacecraft was faster, cheaper but not better, NewScientist, 14 June 2006[Online, accessed 12 December 2006]. URL: www.newscientist.com

McKenna, T, 2003, 2003 Coalition C4 Tests Conclude, JED, *The Journal of ELEKTRONIC DEFENSE*, August 03, p 38, [Online, accessed 12 December 2004]. URL: www.jedonline.com

McKeon, B.M., 2003, *Systems of Systems development in Network Centric Environments*, AIAA 2003-2736, American Institute for Aeronautic & Astronautics, Washington, USA.

McLucas, A. C. 2003. *Decision Making: Risk Management, Systems Thinking and Situation Awareness.* Argos Press. Canberra, Australia

Meyer, P.K., 2003, *Realizing UAV's Transformational Potential: The Emerging Technology Agenda*, AIAA 2003-2737, American Institute for Aeronautic & Astronautics, Washington, USA.

MIL-A-8591, 1995, *Airborne Stores, Suspension Equipment and Aircraft-Store Interface (Carriage Phase); General Design Criteria*, US Department of Defence Military Specification, Revision H, USA dated June 1995

MIL-HDBK-1763, 1998, *Aircraft Stores Compatibility: Systems Engineering Data Requirements and Test Procedures*, US Department of Defence Handbook, 15 June 1998, USA.

Millet, S. 2005, *Implementing a Single Mission data Interface for a Platform/Weapon Integration - MIL-STD-3014*, USN NAVAIR [Online, accessed 13 May 2004]. URL: http://mil-std-3014.navy.mil/

MIL-STD-810, 2000, *Environmental Engineering Considerations and Laboratory Tests*, US Department of Defence Standard, Revision F, USA.

MIL-STD-881, 1993, Work Breakdown Structures, US Department of Defence Standard, Revision B, USA.

MIL-STD-882, 2000, *Standard Practice for System Safety*, US Department of Defence Standard, Revision D, USA.

MIL-STD-1289, 2003, *Requirements For Airborne Stores Ground Fit and Compatibility*, US Department of Defence Standard, Revision D, 24 September 2003

MIL-STD-1521, 1985, *US DoD Technical Reviews And Audits For Systems, Equipments, And Computer Software Distribution*, US Department of Defence Standard, Revision B, USA. dated 4 June 1985. [Online, accessed 1 December 2004],

URL: http://home.btconnect.com/managingstandard/1521b.htm

MIL-STD-1472, 1999, Human Engineering, US Department of Defence Standard, Revision F, 23 August 1999

MIL-STD-1553, *Interface Standard for Interface Digital Time Division/Command Response Multiplex Data Bus*, US Department of Defence Standard, Revision B 15 January 1996, Notice 4

MIL-STD-1760, *Interface Standard for Aircraft/Store Interconnection System,* US Department of Defence Standard, Revision D, 2004

MIL-STD-3014, *Mission Data Exchange Format*, US Department of Defence Standard, USA. [Online, accessed 21 July 2004], URL: http://mil-std-3014.navy.mil

Moffat, Dr J. 2003, *Complexity Theory and Network Centric Warfare*, Command and Control Research Program, [Online, accessed 1 December 2004], URL: http://www.dodccrp.org

Morton, P, 1989, *Fire Across the Desert – Woomera and the Anglo-Australian Joint Project 1946 – 1980*, Australian Government Publishing Service, Canberra, Australia

Moon, T., Smith J., & Cook, Prof S., 2006, *Technology Readiness & Technical Risk Assessment for the Australian Defence Organisation*, SETE 2006 Conference Paper, Brisbane, Australia

Myers, Dr M.E., 2004, *Power to the Edge through Net Centricity – the GIG*, DISA Website, [Online, accessed 13 December 2004]. URL: http://ges.dod.mil/articles/netcentricity.htm

NATA, *National Association of Testing Authorities*, [Online, accessed 13 January 2005]. URL: http://www.nata.asn.au/

NATO, 2002, *NATO Code of Best Practice for C2 Assessment*, Command and Control Research Program, [Online, accessed 10 July 2007].

URL: http://www.dodccrp.org

NATO, 2002a, *NATO Code of Best Practice for C2 Assessment – Analysts Summary Guide*, Command and Control Research Program, [Online, accessed 10 July 2007].

URL: http://www.dodccrp.org

NDIA, 2007, NDIA Top Issues for US National Security and defence industrial base, National Defense Industrial Association, [Online, accessed 10 July 2007].

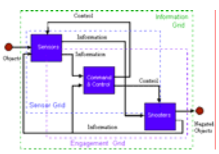
URL:
http://www.ndia.org/Content/NavigationMenu/Advocacy/FINAL_2007_Top_Issues.pdf

Nelson, Dr B., 2006, Defence Awards $201m AP-3C Orion Deeper Maintenance Contract To Australian Aerospace, Media Release, 20 Dec 2006, . [Online, Accessed 12 December 2006]. URL: http://www.minister.defence.gov.au/NelsonMintpl.cfm?CurrentId=6280

Nesterov, Dr S., Kennedy, D., Simmonds S., 2007, *Software Maintenance in Avionic Mission Systems: A Case Study*, SETE Proposed Paper, University of South Australia

Newton, C.O. 1996, Design Assurance for Airborne COTS Hardware, *IEEE Colloquium on Cots and Safety Critical Systems*, Digest No. 1997/013 Page(s): 4/1 -4/3.

OFT, 2004, Elements of Defense Transformation, Office of Force Transformation, US DoD, October 2004 [Online, accessed 13 July 2007], URL: http://www.oft.osd.mil



OFT, 2005, *The Implementation of Network-Centric Warfare, Office of Force Transformation*, US DoD, 5 January 2005 [Online, accessed 9 July 2007], URL: http://www.oft.osd.mil

O'Donoghue, T., Rabin, M., 2000, *The Economics of Immediate Gratification, Journal of Behavioural Decisions Making*, John Wiley & Sons, Ltd, 13: 233-250

Onley, D.S., 2007, IT Tools are clogging the airwaves – Officials fret over poor spectrum management, *GCN*, 25 August 2006 [Online, accessed 21 February 2007].

URL: http://www.gcn.com/print/25_29/42028-1.html

Ormerod, P. 2005. *Why Most Things Fail…And How to Avoid it.* Faber & Faber Limited, London, Great Britain.

Ould, M.A. 1999, *Managing Software Quality & Business Risk*, John Wiley & Sons Ltd, USA

Oxford Concise Dictionary, 1964, *The Concise Oxford Dictionary of Current English*, Oxford University Press, London.

Parikh, Ms P., 2007, *Risk Assessment Driven Process Framework for Maintenance and Enhancement of the AP-3C Software Intensive System,* Research Proposal submitted for the Degree of Master of Systems Engineering, 31 January 2005, University of South Australia, Mawson Lakes, SA, 5095

Pennock, M., and Haimes, Y.Y., 2002, Principles and Guidelines for Project Risk Management, *Systems Engineering*, Vol. 5, No 2, 2002, Wiley Periodicals, Inc.

Philips, M, 2004, *The Discipline of Modelling & Simulation*, Virginia Modelling, Analysis and Simulation Centre, Norfolk Virginia, USA [Online, accessed 14 January 04].

URL: www.vmasc.odu.edu

Qurashi, Dr Z.H., 2007, *A Review of Accident Modelling Approaches for Complex Socio-Technical Systems*, Extended Paper Presentation 28 June 2007, Defence and Systems Institute, University of South Australia

RTCA DO-178B, 1992, *Software Considerations in Airborne Systems and Equipment Certification*, Radio Technical Commission for Aeronautics, Washington, USA.

RTCA DO-254, 2000, *Airborne Systems and Equipment Certification*, Radio Technical Commission for Aeronautics, Washington, USA.

Robbillard, T., 2005, *Acquisition at the Air Armament Center*, Director Air-to-Missile Systems Wing, Eglin AFB, FL Presentation to the Precision Strike Conference, NDIA, Jul 2005. [Online, accessed 15 December 2006].

URL: http://www.dtic.mil/ndia/2005precision_strike_peo/2005precision_strike_peo.html

Rutan, DR B, *Breakthroughs – the Product of Innovators*, Presentation to the Pacific Theatre Operational Science and Technology Conference, Hawaii, 3 April 2007. [Online, accessed 25 August 2007].
URL:http://www.dtic.mil/ndia/2007pto/Wednesday/MrBurtRutan.pdf

Rutledge, Ms L, 2004, *Networking Weapons*, AAC/XR Presentation to Emerald Chapter of ITEA, 21 October 2004, Eglin Officers Mess, Eglin AFB, FL.

Ryan, Dr M, 2003, *Some Thoughts on Practical Approaches for Complex Systems*, Keynote Address SETE 2003, SESA Newsletter No 31, December 2003

SAE ARP 4754, 1996-11, *Aerospace Recommended Practice - Certification Considerations for Highly-Integrated or Complex Aircraft Systems,* Society of Automotive Engineers Inc, USA.

SAE ARP 4761, 1996-12, *Aerospace Recommended Practice - Guidelines & Methods for Conducting the Safety Assessment Process on Civil Airborne Systems & Equipment*, Society of Automotive Engineers Inc, USA.

Saunders, S., 2004, *Working Towards a More Effective Design Review Process – Partnered Design Reviews*, SETE Conference 2004, Adelaide, South Australia

Schneier, Bruce, 2004, *Secrets & Lies, Digital Security in a Networked World, with new information about post 9/11 security,* Wiley Publishing, Inc., USA.

Shattuck, L.G. Miller, N.L. Miller, G.A, 2007, *Using the Dynamic Model of Situated Cognition to Asses Network Centric Warfare in Field Settings,* 12^{th} ICCRTS "Adapting C2 to the 21^{st} Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Shenhar, DR A.J. & Bonen, Dr Z, 1997, The New Taxonomy of Systems: Toward an Adaptive Systems Engineering Framework, IEEE *Transactions on Systems, Man and Cybernetics – Part A, Systems and Humans*, Vol. 27, No 2 March 1997

Singer, RADM A, 2007, *Intelligence Perspective - U.S. Pacific Command***,** Director & J2 Joint Intelligence Operations Center, US PACOM Presentation to the Pacific Theatre Operational Science and Technology Conference, Hawaii, 3 April 2007. [Online, accessed 25 August 2007]. URL: http://www.dtic.mil/ndia/2007pto/Tuesday/RADMAndrewSinger.pdf

Signori, D.A., Alberts, Dr D.S. Garstka, J., Hayes Dr R.E, 2001, *Understanding Information Age Warfare*, August 2001, Command and Control Research Program, [Online, accessed 1 January 2007].

URL: http://www.dodccrp.org

Silvia, D. & Doris, K, 2007, *Tactical Application of Gaming Technologies for Improved Battlespace Management.* 12^{th} ICCRTS "Adapting C2 to the 21^{st} Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Slade, G., 2006, *Made to Break – Technology and Obsolescence in America*, Harvard University Press, Cambridge Massachusetts, USA

Smith, Dr E.A., 2003, *Effects Based Operations – Applying network centric warfare in peace, crisis and war*, Command and Control Research Program, USA [Online, accessed 1 December 2004]. URL: http://www.dodccrp.org

Smith, Col (ret.) K.B., 2007, *The Practical Challenges of Realizing Toffler's Third Wave,* 12^{th} ICCRTS "Adapting C2 to the 21^{st} Century" ", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

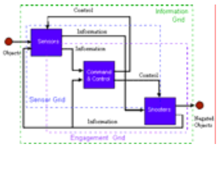
Smith II, J.D., Philips, D.M., 2006, *Interoperable Acquisition for Systems of Systems: The Challenges,* Technical Note CMU/SEI-2006-TN-034, September 2006, Software Engineering Institute, Carnegie Mellon University

Smith, L, 2007, *A "Fly-Fix-Fly" Approach for the P-3 Aircraft Upgrade (F3 4 P-3),* ADF DGTA Software Symposium 2007, RAAF Base Laverton, VIC, 22 August 2007.

Smith, LtCol T, 2006, *Joint Feasibility Study - Joint C2 of Net-Enabled Weapons*, Technical Advisory Board II, Joint Forces Command, 12 Jul 2006

Society of Automotive Engineers Standards, 2007, *The Emerging SAE AADL Standard: An Architecture Analysis & Design Language for Building Embedded Real-Time Systems*, AS-2C AADL Subcommittee, Society of Automotive Engineers Inc, USA. [Online, accessed 14 July 2007] URL: http://www.sae.org

Stanton, D. 2001, *The Design of the Aeroplane,* 2^{nd} Ed, Blackwell Science Ltd, UK.



Stein, F.P., Alberts, Dr D.S. Garstka, J., 2000, *Network Centric Warfare: Developing and Leveraging Information Superiority*, 2nd Edition, Command and Control Research Program, [Online, accessed 1 September 2006] URL: http://www.dodccrp.org

Stotts, Dr L, et al, 2007, *DARPA Networking and Communications Overview*, Presentation to the Pacific Theatre Operational Science and Technology Conference, Hawaii, 3 April 2007. [Online, accessed 25 August 2007].
URL: http://www.dtic.mil/ndia/2007pto/Wednesday/DrLarryStotts.pdf

Stuckey, Col R, 2007, *Distributed Test, Training and Experimentation Keynotes*, US DoD OSD Presentation to IDC 2007 Conference, Hilton, Adelaide, South Australia, February 2007

Sun Tzu, 500 BCE, *On the Art of War*, Translated from the Chinese by Lionel Giles, M.A. Department of Oriental Printed Books, British Museum, First Published in 1910 [Online, accessed 14 December 2004]

URL: http://www.kimsoft.com/polwar.htm

Surowiecki, J. 2004. *The Wisdom of Crowds, Why the Many are Smarter than the Few.* Abacus Books, Clays Ltd, Great Britain.

Tan, Col(NS) D. SOH, LTC F.J. NG, E.C. ANG, C.K. Ng, Dr. F.M. Chia, Dr. C.W., 2007, *Flexible Utilisation of Limited Airspace in the Republic of Singapore, C2 Concepts, Theory & Policy Track*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007]

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Tenix FX-0119A001-A, 2007, *P-3 Engineering Management Plan*, Revision C, Tenix Aerospace & Defence Pty Ltd, 28 February 2007

Tenix FX-0119A001-A-20, 2007, *P-3 Systems Engineering & Certification Guidelines*, Tenix Aerospace & Defence Pty Ltd, 28 April 2007

Thamhain, H, 1992, *Engineering Management – Managing Effectively in Technology-Based Organisations*, John Wiley & Sons

Thoreson, Dr D., *JP 2072 Battlespace Communication System,* DEF.NET 2006 Symposium, National Wine Centre, Adelaide, November 2006.

Tutty, M.G. 2004, *Aircraft stores certification and interoperability – an Australian perspective on where to from here*, Invited Paper 1 at NATO Research & Technology Organisation RTO AVT-108 Applied Vehicle Technology Symposium, Williamsburg VA, June 2004

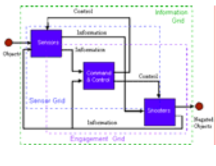
Tutty, M.G., 2005, *Australian Aircraft Stores Capabilities in Network Enabled World*, Masters Thesis submitted for the Degree of Master of Systems Engineering, 31 January 2005, University of South Australia, Mawson Lakes, SA, 5095

Tutty, M.G. 2006, *The future of aircraft stores compatibility systems engineering in the paradigm of an alliance focused acquisition, network enabled world,* 14th ASC Symposium International Test and Evaluation Association, Ft Walton Beach FL, April 2006.

Tutty, M.G., 2007, *Airpower in an Alliance-based, network-enabled world – Lessons Learned during our Journey so far …*, Inaugural Asia Pacific Systems Engineering Conference, April 2007.

Unknown, Undated, *Draft Experimentation Typology*, Command and Control Research Program, [Online, accessed 9 July 2007]. URL: http://www.dodccrp.org

Van Bezooijen, B.J.A. Essens, P.J.M.D., 2007, *Situation Awareness in Modern Military Operations*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],



URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Watts, Dr D.J. 2002, *Six Degrees – the science of a connected age*, W.W. Norton & Company Ltd, NY, NY, USA

Weir, A., 2000, *The Tombstone Imperative – The Truth about Air Safety*, Simon & Schuster UK Ltd, UK.

Wells, Dr L, 2007, *Adapting C2 for the 21st Century*, Keynote Address at the 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Welsh, Brigadier D, 2006, *Explaining the NCW Roadmap*, DEF.NET 2006 Symposium, National Wine Centre, Adelaide, November 2006.

Whitt, Dr. L., 2007, *Why is C41 Software so Hard to Develop?*, 12th ICCRTS "Adapting C2 to the 21st Century", Newport, Rhode Island, USA, 19-21 June 2007 [Online, accessed 9 July 2007],

URL: http://www.dodccrp.org/events/12th_ICCRTS/CD/iccrts_main.html

Wiki, 2007, Wikipedia Asymmetric warfare.definition, [Online, accessed 29 July 2007],

URL:http://en.wikipedia.org/wiki/Asymmetric_warfare.

Wilson, Brigadier R, 2004, *Network Centric Warfare Roadmap*, Director of Future Warfighting Concepts, Presentation to DSTO NCW Symposium, DSTO Edinburgh SA, 23 November 2004.

Winter, CAPT M USN, *Network Enabled Weapons – Another Node in the Network*, Presentation to Precision Strike Symposium, 19 Oct 2006, [Online, accessed 19 July 2007],

URL: http://www.dtic.mil/ndia/2006psa_psts/winter.pdf

Winters, Brigadier P, 2007, *Brief to DSTO*, Commander Counter IED Task Force, 28 July 2007, DSTO Edinburgh, SA

Woitalla, M.J., 2006, *Joint Approach for Target Management for the Precision Strike of Time Sensitive Targets*, Raytheon Presentation to Precision Strike Symposium, 19 Oct 2006, [Online, accessed 19 July 2007], URL: http://www.dtic.mil/ndia/2006psa_psts/woit.pdf

Woodcock, Major W.A., 2003, The Joint Forces Air Command Problem: Is Network-centric Warfare the Answer, *Naval War College*, Winter 2003, Vol 1.VI. No. 1, [Online, accessed 10 December 2004]. URL: http://www.nwc.navy.mil/press/Review/2003/Winter/pdfs/art5-w03.pdf

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